Question number	Answer	Marks	Guidance
1 (a)	n(NaOH) = 0.125 × 22.40/1000 = 2.80 × 10^{-3} mol	B1	
1 (b)	n(NaOH) = 0.5 × 2.80 × 10^{-3} = 1.40 × 10^{-3} mol	B1	
1 (c)	c = 1.40 × 10^{-3} × 1000/25.0 = 0.0560 mol dm^{-3}	B1	
2	N in NH_3 has been oxidised from –3 to 0 in N_2 Cu in CuO has been reduced from +2 to 0 in Cu	B1 B1	
3 (a) (i)	Mg has lost 2 electrons and has been oxidized Fe has lost 3 electrons and has been reduced	B1 B1	
3 (a) (ii)	iron(III) nitrate(V)	B1	
3 (b) (i)	Mn has been reduced from +4 in MnO_2 to +2 in $MnCl_2$	B2	
3 (b) (ii)	In HCl, Cl has oxidation number of –1. Cl has been oxidised from –1 in HCl to 0 in Cl_2 Cl in HCl has an oxidation number of –1 which is unchanged in $MnCl_2$	B1 B1	
4 (a) (i)	For each equation, 1 mark for balanced equation, 1 mark for state symbols. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ $CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$ $Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$	 B1 x 2 B1 x 2 B1 x 2	
4 (a) (ii)	An acid has been neutralised by a base to form water	B1	
4 (a) (iii)	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	B1	
4 (b) (i)	Reduction is increase in oxidation number and gain of electrons Oxidation is decrease in oxidation number and loss of electrons	B1 B1	
4 (b) (ii)	$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(g) + H_2(g)$	B2	
4 (b) (iii)	Ca has been oxidised from 0 to +2 H has been reduced from 1+ to 0.	B1 B1	
5 (a)	$WO_3 + 3H_2 \rightarrow W + 3H_2O$	B1	

Question number	Answer	Marks	Guidance
5 (b)	Oxidation is loss of electrons Reduction is gain of electrons	B1	
5 (c)	H has been oxidised and W has been reduced H in H_2 has been oxidised from 0 to +1 in H_2O W in WO_3 has been reduced from +6 to 0 in W	B1 B1 B1	
5 (d)	Mass of WO_3 in 100 tonnes of ore = 2 tonnes $M(WO_3)$ = 231.8 g mol^{-1} $n(WO_3) = 2 \times 10^6/231.8 = 8628$ mol mass of W = $8628 \times 183.8 = 1.59 \times 10^6$ g (1.59 tonnes)	B1 B1 B1 B1	
6 (a)	$n(H_2SO_4) = 0.125 \times 24.40/1000 = 3.05 \times 10^{-3}$ mol	B1	
6 (b)	$n(NH_3) = 2 \times 3.05 \times 10^{-3}$ mol = 6.10×10^{-3} mol	B1	
6 (c) (i)	$c = 6.10 \times 10^{-3} \times 1000/25.0 \times 10$ (for initial dilution = 2.44 mol dm^{-3}	B1	
6 (c) (ii)	$2.44 \times 17 = 41.46$ g dm^{-3}	B1	
7 (a) (i)	Mg in Mg has been oxidised from 0 to +2 in $MgSO_4$ H in H_2SO_4 has been reduced from +1 to 0 in H_2	B1 B1	**ALLOW** correct oxidation numbers shown in equation 2nd mark is dependent on identification of Mg **IGNORE** electrons
7 (a) (ii)	bubbles **OR** fizzes **OR** effervesces **OR** gas produced Mg/solid dissolves **OR** Mg/solid disappears **OR** (Mg/solid) forms a solution	B1 B1	**IGNORE** metal reacts **IGNORE** temperature change **IGNORE** steam produced **DO NOT ALLOW** carbon dioxide gas produced **DO NOT ALLOW** hydrogen produced without gas
7 (b) (i)	$M(MgSO_4)$ = 120.4 g mol^{-1} $n(MgSO_4) = 1.51/120.4 = 1.25 \times 10^{-2}$ mol	B1 B1	**ALLOW** 0.013 up to calculator value of 0.012 541 528 correctly rounded (from M = 120.4 g mol^{-1}) **ALLOW** 0.013 up to calculator value of 0.012 583 333 correctly rounded (from M = 120 g mol^{-1}) **ALLOW** ecf from incorrect M i.e. 1.51 ÷ M
7 (b) (ii)	$n(H_2O) = 1.57/18 = 8.72 \times 10^{-2}$ mol	B1	**ALLOW** 0.09 up to calculator

Question number	Answer	Marks	Guidance
			value of 0.087 222 22
7 (b) (iii)	$x = n(H_2O)/n(MgSO_4) = 7$	B1	**ALLOW** ecf i.e. answer to (ii) ÷ answer to (i) **ALLOW** correctly calculated answer from 1 significant figure up to calculator value, ie, x does not have to be a whole number. Likely response = 6.95
8 (a) (i)	The H^+ ion in an acid has been replaced by a metal ion/Ca^{2+}	B1	**DO NOT ALLOW** it has been produced by the reaction of an acid and a base as this is stated in the question. **IGNORE** references to replacement by NH^{4+} ions or positive ions. **ALLOW** H OR Hydrogen for H^+; **DO NOT ALLOW** Hydrogen atoms **ALLOW** Ca OR Calcium for Ca^{2+}. **DO NOT ALLOW** Calcium atoms **ALLOW** 'metal' for 'metal ion
8 (a) (ii)	$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$ 1 mark for Formulae 1 mark for Balance and state symbols	B1 x 2	**ALLOW** multiples **ALLOW** (aq) **OR** (s) for $Ca(OH)_2$
8 (a) (iii)	Accepts a proton/H^+	B1	**ALLOW** $H^+ + OH^- \rightarrow H2O$ **ALLOW** OH^- reacts with H^+ OR OH^- takes H^+ **ALLOW** OH^- 'attracts' H^+ if 'to form water' is seen **DO NOT ALLOW** OH^- neutralises H^+ ('neutralises' is in the question)
8 (b) (i)	$n(NaOH) = 0.0880 \times 25.0/1000 = 2.20 \times 10^{-3}$ mol	B1	**ALLOW** 0.0022 **OR** 2.2×10^{-3} mol
8 (b) (ii)	$n(H_2SO_4) = 0.5 \times 2.20 \times 10^{-3} = 1.10 \times 10^{-3}$ mol	B1	**ALLOW** 0.0011 OR 1.1×10^{-3} mol **ALLOW** ECF for answer **(i)**/2 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes
8 (b) (iii)	$c = 0.00110 \times 1000/17.60 = 0.0625$ mol dm^{-3}	B1	**ALLOW** 0.063 OR 6.3×10^{-2} mol dm^{-3} **ALLOW** ECF for answer **(ii)** × 1000/17.60

Question number	Answer	Marks	Guidance
			OR ECF from **(i)** for answer **(i)**/2 × 1000/17.60 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes
8 (c) (i)	Water of crystallisation	B1	IGNORE hydrated OR hydrous
8 (c) (ii)	$M(Na_2SO_4) = 142.1\ g\ mol^{-1}$ $x = (322.1 – 142.1)/18.0 = 10$	B1 B1	**ALLOW** 142 **ALLOW** M_r expressed as a sum **ALLOW** ECF from incorrect Mr and *x* is **calculated correctly** **ALLOW** ECF values of *x* from nearest whole number to calculator value **ALLOW** 2 marks if final answer is 10 **without any working**
9 (a)	$n(KOH) = 0.224 \times 25.00/1000 = 5.60 \times 10^{-3}$ mol n(**A**) $= 0.5 \times 5.60 \times 10^{-3} = 2.80 \times 10^{-3}$ mol	B1 B1	
9 (b)	n(**A**) in 250 $cm^3 = 2.80 \times 10^{-3} \times 250/31.25$ $= 2.24 \times 10^{-2}$ mol $n = m/M$. ∴ $M = m/n = 2.6432/2.24 \times 10^{-2}$ $= 118\ g\ mol^{-1}$	B1 B1	
9 (c)	H : C : O = 40.68/12.0 : 5.08/1.0 : 54.24/16.0 = 3.39 : 5.08 : 3.39 Empirical formula = $C_2H_3O_2$ Molecular formula = $C_2H_3O_2 \times 118/59$ = $C_2H_3O_2 \times 2 = C_4H_6O_4$	B1 B1 B1	
9 (d)	$C_4H_6O_4(aq) + 2KOH(aq) \rightarrow K_2C_4H_4O_4(aq) + 2H_2O(l)$	B1	